APPENDIX A

I-PLAN

for

GEODETIC CONTROL

GEODETIC CONTROL
IMPLEMENTATION PLAN

EXECUTIVE SUMMARY

This document is Idaho's Implementation Plan (I-Plan) for Geodetic and Mapping Control describing Idaho's five-year vision for the desired state of geodetic and mapping control. Topics covered include the geographic distribution of control monuments, the reliability of, public access to and use of geodetic and mapping control information, recommendations for standards for control points, standards for reporting control information, recommendations for education and outreach, and estimated costs and timelines for realizing this vision.

The Federal Geographic Data Committee (FGDC) has classified Geodetic Control as one of the seven national framework data themes. In writing this I-Plan, the Geodetic Control Technical Working Group (GCTWG) has attempted to identify issues and recommend solutions associated with geodetic and mapping control in Idaho. This I-plan will be incorporated into the overall strategic I-Plan for the development of Idaho Spatial Data Infrastructure (ISDI).

VISION

In Idaho geodetic and mapping control is readily available to all in a format that is easy to access and is useful for a variety of applications.

GUIDING PRINCIPLES

i. Everyone should have easy access to public information.
ii. Public agencies should share their control as a common resource.
iii. Idaho's procedures and processes should be consistent with national efforts.
iv. Appropriate metadata is mandatory.
v. Reporting methods should be automated as much as possible.
vi. An environment that fosters public-private partnerships benefits all players.

WHAT IS GEODETIC AND MAPPING CONTROL?

Control points are locations that have coordinates which are derived relative to a reference frame. Reference frames may take many forms, including assumed coordinates for local reference systems. However, in order to be able to share information among various agencies within the same geographic area, or across broader landscapes, it is important to have a ***common*** frame of reference. The federal government charges the National Geodetic Survey (NGS) of the National Oceanic and Atmospheric Administration (NOAA), with responsibility for establishing and maintaining a common reference system for the entire United States and its territories. This common reference system is the official reference system for the country and is designated the National Spatial Reference System (NSRS). Mapping and surveying works can be connected to the NSRS by tying new projects to previously established control points that are part of the NSRS.

In addition to the control maintained by the NGS there are many thousands (and perhaps millions) of additional control points established throughout the country which are not part of the NSRS but have been connected to it. These control points may be local control, such as for a city, or project control, such as established by state highway departments, or private surveying firms. The scope of this document is focused on the estimated 99 percent of control points that are not currently part of the NSRS. Despite the fact that public funds are used to create much of the control that exists, very few of those control points become part of the public record. This I-Plan is intended to address these issues and provide recommendations to help correct the current situation.

Definitions from *Draft Version 1.0 (1/08/03) National Spatial Data Infrastructure Framework Data Content Standards - Geodetic Control)*

(From Base Standard document)

Geodetic Control *provides a common, consistent, and accurate reference system for establishing coordinates for all geographic data. All NSDI framework data and users' applications data require geodetic control to accurately register spatial data. The fundamental geodetic control for the United States is provided through the NOAA managed National Spatial Reference System (NSRS).*

National Spatial Reference System *(NSRS) is a consistent coordinate system that defines and includes latitude, longitude, height, scale, and orientation throughout the United States, and how these values change with time.*

(Additions)

Control *is high-accuracy spatial data associated with a collection of well defined and consistently referenced ground points, usually given as coordinate data.*

Geodetic Control *is a set of control points (also commonly referred to as "stations") whose coordinates are established by geodetic surveying methodology.*

Horizontal Geodetic Control: *These data of geodetic control consist first of distances, directions, and angles between control stations. These are converted to geodetic coordinates [i.e., geodetic latitudes and longitudes] and azimuths. The former, in turn, may be converted into other kinds of coordinates such as plane coordinates in a State Plane Coordinate System. This is the form in which they are usually used in the United States for local surveys.*

Vertical Geodetic Control: *These control points are those whose elevations [i.e., orthometric heights] have been accurately determined, can be identified with physical points on the Earth, and can be used to provide elevations for other surveys. Elevations are referred, by definition, to the geoid. However, horizontal surfaces through selected points on mean sea level have been used for reference, as have non-horizontal surfaces defined by a combination of leveling surveys and points on mean sea level.*

Other Definitions

Control point *means a horizontal or vertical coordinate position tied, within a known precision, to a spatial reference system. A control point may or may not designate the coordinate position of an actual physical monument, that is, a control point might not have a monument associated with it.*

Control Monument *means a stable persistent physical object that designates the location on the ground of a coordinated horizontal or vertical position.*

Mapping control *means horizontal or vertical control points that are used to position maps in coordinate space. Mapping control may be used for a variety of mapping projects including, but not limited to, aerial photography, parcel mapping, and GIS. Mapping control may or may not designate the coordinate position of an actual physical monument.*

Throughout this document we will refer to geodetic and mapping control with the more generic term "control."

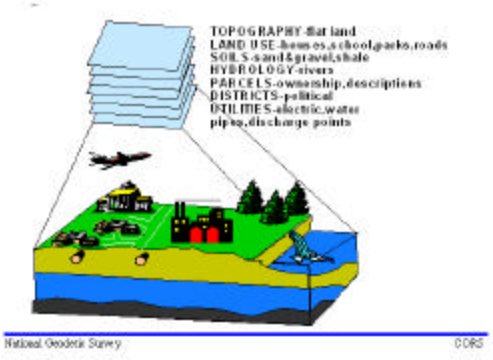
WHY CONTROL IS IMPORTANT TO IDAHO.

Control is typically not an end itself, but a means to an end. Mapping and GIS can be done without survey control; however, reliability of the end product is enhanced when based on control. Control is somewhat of an anomaly when viewed in conjunction with other data themes contained in both NSDI and ISDI. While it is important as a critical foundation of other themes like cadastral and ortho-imagery, it is seldom used by itself to conduct the types of mapping and analysis functions typically performed using GIS software. In many instances it has taken a back seat to other spatial data collection efforts, especially when those efforts were conducted without input from the survey community. However, the National Research Council recognized the importance of this layer when it published the Need For A Multipurpose Cadastre in 1980. It reported that, *"3.1 GEODETIC REFERENCE NETWORK - A survey control base is needed to create an integrated land records and information system. Monumented points whose coordinates have been determined with respect to the national geodetic control system constitute such a system. This system permits spatial reference of all land data to identifiable points on the earth's surface."*

Whether or not one accepts a total linkage to the NGS, control can be said to be vital to the collection or adjustment of other spatial data. For example, the Bureau of Land Management's (BLM) Geographic Coordinate Database (GCDB) relies on control of several types to define the most widely accepted digital version of the Public Land Survey (PLSS). Enhancement (either re-monumentation or an update of coordinates) of control associated with PLSS monumentation will result in a more spatially accurate GCDB. This can in turn result in a more spatially accurate cadastral theme and many other themes associated with PLSS lines such as land stewardship and jurisdictional boundaries.

Geographic Information Systems and land surveying activities require control for a variety of reasons, such as:

- Establishing a mapping relationship to other existing data (e.g. other GIS layers)
- Discovering and potentially reconciling discrepancies between conflicting data sets (such as gaps and overlaps)
- Providing a reference coordinate system for project data
- To reduce mapping errors as new data are created
- To constrain mapping errors within a geographic area
- To improve the spatial accuracy of existing data sets
- To provide reference points that enable the sharing of data within a geographic area



Conversion of maps into digital format for GIS requires some sort of control for the correct placement of data into geographic space.

Some of Idaho's primary needs for survey control include:

- GCDB to parcels
- Highway projects
- Critical infrastructure
- Parcel mapping
- Private industry GIS

ISSUES

Institutional Barriers

Control data generated from public funds within an agency, department, or private entity is not readily available.

Control data is not based on a common, community-endorsed reference frame.

Financial Barriers

Existing control is not available in digital format and will require considerable energy to convert to digital format and provide quality assurance of the integrity of the data.

Educational Barriers

Rapidly emerging technologies require greater coordination and understanding between those that generate and perpetuate control and the users that manipulate coordinates based on that control.

KEY OBJECTIVES

I. Promote public access to public control data.

II. Promote the use of standards for reporting control data.

III. Develop an on-line database for storing, querying, and accessing control data.

IV. Ensure that control generated with public funds be submitted to the public database.

V. Promote training and education opportunities to foster an understanding of the value and use of control.

VI. Encourage cooperation on control projects.

IDAHO GEODETIC AND MAPPING CONTROL

STATUS

Significant quantities of existing control are known to exist in Idaho, including Public Land Survey System (PLSS) corners, and survey, mapping, resource and construction grade control. This control has been acquired over the years by mostly project specific governmental activities, and little coordination of data collection or archiving exists. The following local, state, and federal agencies, as well as private entities, are known to possess existing control data:

- Local Cities and Counties – For example, it is estimated that Ada County has geodetic control on most of its PLSS corners and numerous subdivision controlling corners.

- State of Idaho – Several state agencies are known to acquire and possess existing project specific geodetic control. The primary agencies possessing such data are Transportation (ITD), Lands, Water Resources, and Parks and Recreation Departments.

- Federal – The majority of existing control in Idaho PLSS corners, as well as survey, mapping and construction control, is held by several federal agencies: NGS, USGS, Federal Highway Administration, Bureau of Land Management (BLM), Bonneville Power Administration, U.S. Forest Service (USFS), Bureau of Reclamation (BOR), Corps of Engineers, National Park Service, Federal Aviation Administration, Federal Communications Commission, and Environmental Protection Agency.

- Private – Private sources of existing control would include utility companies such as power companies and communications providers, as well as privately held control created by Idaho surveyors.

Any plan to densify control requires, as a first step, the creation of a Control Database that documents existing control and serves as a tool to help identify areas in need of densification. An accumulation of the existing control in one single accessible database would likely result in literally thousand of points and may adequately cover the developed portions of Idaho. Therefore, it seems prudent that before Idaho develops and undertakes a project specifically aimed at densifying control, an initial effort be aimed at inventorying existing control. Initial efforts to populate a Control Database should focus not only on the addition of newly created points, but perhaps more importantly, importation of existing control. Presently, new control continues to be generated by the same noted local, state, and federal agencies, without a coordinated effort to standardize the data and provide access to archives. There is a need to fund and examine the feasibility of collecting existing PLSS control from existing sources, as well as constructing a prototype web-enabled database that could hold existing control data and provide forms for new data entry. Feedback on these two efforts would need to be reviewed with recommendations placed forward.

COORDINATION

Coordination of the Control Database could be spearheaded by the State GIS Coordinator's Office or another agency (state or federal) willing to accept the task. It is anticipated that development of the database software and initial data entry will require the efforts of one, full-time technician for a period of two years. Extensive coordination with the noted local, state, and federal agencies will be necessary to acquire the existing control that will be new to the system. It is likely that significant effort will be devoted to manual formatting and entry of existing data. Subsequent entry of new data and operation/maintenance of the system is expected to require one-quarter of a full-time position.

- The players include but are not limited to the BLM, USGS, USFS, BOR, ITD, Land surveyors, local government, tribes.
- Control densification project coordination - NGS
- New data contributors

RECOMMENDATIONS

- Identify existing data holders (Authors)
- Identify existing control and its accessibility
- Develop a plan for densifying control where needed.
- Coordinate control projects whenever possible.
- Promote adding new control data to a common database.
- Create a statewide, densified Continuously Operating Reference Station (CORS) network.

TASKS AND TIMELINES

Task and timelines are general issues common to the whole plan and not necessarily specific to "new control." Open questions and challenges are determining cost, finding the funding, finding the personnel, and implementing the plan.

COSTS

The GCTWG wishes to defer estimation of total costs for new control until such time as an adequate inventory of existing control is in place. It is interesting to note that Utah has estimated the cost of 700 high-order stations coincident with PLSS township corners at $4.9 million, or $7,000 per station. Costs per station in Idaho are estimated to be in the $500-1,500 range.

As referenced above, the cost of in-house staff to construct and populate the Geodetic Control Database would likely be in the $50,000-60,000 per year range for at least two years. This includes salary, benefits, and a substantial amount of in-state travel. This task could be outsourced, but given the extensive interagency coordination required and factoring in the travel,

costs for this option would likely be about $100,000 per year. Long-term maintenance, given our current knowledge base, will be approximately $15,000 per year.

A 20-station CORS network, spaced approximately 60 miles apart throughout Idaho would provide a direct, consistent connection to the NSRS for all newly collected coordinate data. New CORS cost approximately $17,500 per site. A state coordinated and maintained CORS network would cost approximately $750,000 for the complete 20-station network.

The development of new control should promote opportunities to partner with the private sector.

STANDARDS FOR GEODETIC AND MAPPING CONTROL

STATUS

The Federal Geodetic Control Subcommittee (FGCS), formerly the Federal Geodetic Control Committee (FGCC), has developed standards and specifications for establishing horizontal and vertical control. The NGS has developed a standard format for geodetic survey data, commonly known as the "Blue Book" that must be used if survey control data is to be submitted to the NGS for review and inclusion into the NSRS. While not all survey control for a GIS/LIS needs to be submitted to the NGS, it is advantageous to submit, at a minimum, the primary survey control network of a GIS/LIS to the NGS. Submission and acceptance of control to the NGS provides a quality check on the data and helps strengthen the geodetic network in the local area.

State, county, and local standards for establishing, maintaining, and submitting control at the state level are sometimes available within individual agencies and regionally, but in most instances are non-existent. To date, there has been little coordinated effort to develop standards for establishing, maintaining, submitting, and disseminating control data statewide.

Federal Standards
The NGS is the primary source for control information. However, NGS estimates that it has only about one percent of existing control. The NGS implements strict procedures for planning, observing, analyzing, adjusting, and reporting control, thereby adding approximately 30 percent (by NGS estimates) to the cost of control projects. Standards for establishing, maintaining, and submitting geodetic control data exist at the federal level as referenced below:

FGCS Publications:

- Federal Geodetic Data Committee (FGDC) Geospatial Positioning Accuracy Standards (FGDC-Std-007-1998).
- Federal Geodetic Data Committee (FGDC) Spatial Data Transfer Standard (SDTS), Part 6: Point Profile (FGDC-Std-002.6).
- Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques, Federal Geodetic Control Committee, 1989 or most recent version.
- Standards and Specifications for Geodetic Control Networks, Federal Geodetic Control Committee, 1984 or most recent version.

- Input Formats and Specifications of the National Geodetic Survey Data Base (three-volume Blue Book set), National Geodetic Survey, U.S. Department of Commerce, 1994 or most recent version.
- Multipurpose Land Information Systems – The Guidebook, Federal Geodetic Control Committee, 1989-1994.

Other Publications:

- Standards and Guidelines for Cadastral Surveys Using Global Positioning System Methods, U.S. Forest Service, Bureau of Land Management, Version 1.0, May 9, 2001.
- Need for a Multipurpose Cadastre, National Academy of Sciences, 1980.
- Procedures and Standards for a Multipurpose Cadastre, National Academy of Sciences, 1983.

State Standards

ITD creates control points for highway projects for engineering, right-of-way acquisition, aerial photography, hydrological, and environmental assessment studies. ITD standards for the establishment and submission of control are provided for and referenced in project contracts. Other state agency standards are also provided for and referenced in project contracts. Standards for establishing, maintaining, and submitting geodetic control data exist at the state level as referenced below:

- Idaho Transportation Department – (currently being drafted)

Other Publications:

- North Carolina – Statewide Global Positioning System (GPS) Data Collection and Documentation Standards, State Government GIS user Committee, October 13, 1994.
- Surveying and Geodetic Control Guidelines & Recommendations for Local Geographic & Land Information Systems, GIS Committee of the County Engineer's Association of Ohio, 1998.

Local Standards

There are a variety of both digital and paper records throughout the state recording established control. Access to control records is on a county-by-county basis, which, according to state statutes, should be available to the public. However, knowledge of and access to the data is sporadic and inconsistent. Other than control reporting standards maintained by individual counties there are no acknowledged statewide standards for establishing, reporting, or disseminating control data at the local level

COORDINATION

Representatives from state, federal, county, and local agencies, as well as private individuals, acting as participants in the Idaho Geodetic and Mapping Control Standards Committee, can work to produce statewide standards for establishing, maintaining, submitting, and disseminating

control data that provides the required reporting information and assures quality control. Committee participants include but are not limited to:

- NGS, NSRS, updates and maintenance
- BLM, GCDB, updates and maintenance
- ITD, transportation project control points
- Idaho Society of Professional Land Surveyors (ISPLS), project control and survey data
- Idaho Geospatial Committee (IGC), database development and maintenance

RECOMMENDATIONS

Establish an Idaho Control Standards Committee to evaluate existing control standards to develop and promote state standards for the establishment of control and for the submission and dissemination of control data.

- Provide education about standards.
- Encourage everyone to follow standards.
- Establish an Idaho web-based control database that conforms to national standards.

TASKS AND TIMELINES

The development of statewide standards require individuals representing the various interested agencies as well as other concerned participants in an Idaho Control Standards Committee to review existing standards, propose and draft acceptable statewide standards, place these draft standards through a review process, then produce final standards. This is an arduous task that will require many hours by committee members throughout the process taking them away from their official duties.

Develop state standards for control data submission and dissemination.

- Continue to evaluate existing standards..
- Identify issues pertinent to standards; monumentation, surveying procedures, reports, submission, and dissemination.
- Establish procedures for data submission and dissemination.
- Provide training in the use and submission of geodetic control data.

COSTS

The costs to develop statewide standards are difficult to predict. Individuals representing the various interested agencies, as well as other concerned participants, will be required to spend many hours away from their official duties. Costs of establishing and maintaining statewide geodetic control standards are as follows:

- Costs incurred by participating agencies/individuals for standards development and review.
- Standards publication and maintenance.
- Training in the understanding and use of statewide standards.

DATA ACCESS AND USE

STATUS

NGS data, products, and services are currently available on-line from their website. Other federal agencies create new control for a variety of projects. Most notably are the BLM, USFS, Bureau of Indian Affairs, and BOR. ITD does have control data, but those data are not readily available, not searchable, and are not in a standard transfer format. Other government (federal, state, and local) and private sector control data not identified here probably exist but are not commonly shared.

NGS http://www.ngs.noaa.gov/

- Data Sheets with Control Point Position & Height Information
- CORS GPS Data

  The NGS works with the public and private sectors to obtain and maintain the NSRS, including the creation of new points and the recovery of existing monuments. The NSRS data are available on-line and in other formats from the NGS.

BLM

- Geographic Coordinate Data Base http://www.blm.gov/gcdb/

  The BLM uses control for surveys of the PLSS and the GCDB.

USFS

- GPS Base Station http://www.fs.fed.us/database/gps/

  The USFS uses control for surveys of forest boundaries, forest roads, and other USFS projects. The USFS also provides GPS data for use by the public.

Other state, county, city, and local agencies may require control ties to the NSRS and/or PLSS for easements, land transactions, and construction projects. These control data are typically not shared with the public at this time.

COORDINATION

Little coordination among the public sector agencies for access to and sharing of control data stems from the absence of a unified state policy on sharing and access to public sector data

The Idaho Transportation Department, through a cooperative agreement with the National Geodetic Survey, has contracted the services of an NGS Advisor to the State of Idaho for 80 percent of the year. The NGS Geodetic Advisor position works with the public and government agencies and promotes the coordination in establishment and use of statewide control data.

RECOMMENDATIONS

- Develop a policy for public control data dissemination
- Design and implement an on-line control database that is consistent with other states' control database efforts.
- Input all available existing and new public control data into an on-line database that is available to the public.
- Promote effort to ensure the filing of control data when those data are created with public funds.
- Work with the NGS to maintain an NGS advisor in Idaho

TASKS AND TIMELINES

- Develop a policy for public control data dissemination.
- Identify and review existing control databases
- Develop sample web application

COSTS

- ¼ FTE for web and database programming, maintenance, and data QA/QC
- 1 FTE (½ State funding matched with ½ NGS funding) for an Idaho NGS advisor

EDUCATION AND OUTREACH

STATUS

There is no statewide education effort concerning the need for collecting, use, archiving, or disseminating publicly funded geodetic and mapping control information.

Idaho Society of Professional Land Surveyors and the Idaho GIS community have various opportunities for professional training development and requirements for continuing education, which occasionally address geodetic control, but not in a concerted effort.

The IGC assumes a role for education of policy makers of the usefulness of all framework data layers through the Idaho Spatial Data Infrastructure (ISDI) initiative.

COORDINATION

Coordination of education specifically tailored to collecting, using, archiving, and disseminating control information should be coordinated through the GCTWG I-Plan in conjunction with ISPLS, IGC, and the Integrator (to be named).

Education and outreach on control issues should address the particular needs of:

- Policy makers
- GIS professionals
- Land surveyors, public and private

RECOMMENDATIONS

- Create and support workshops for surveying and GIS professionals on:
  - The value and use of control
  - How to access and use
  - Existing control data.

- Education Partners
  - National Geodetic Survey (NGS)
  - Idaho Society of Professional Land Surveyors (ISPLS)
  - Idaho Geospatial Committee (IGC)
  - The Idaho Geospatial Users Meeting (IGUM)
  - American Congress on Surveying and Mapping (ACSM)

- Proposed Audience
  - GIS professionals
  - Land surveyors
  - University and high school students

TASKS AND TIMELINES

Ongoing training should focus on:

- Educating about this I-Plan
- How it will be used
- How to contribute
- The importance of control

Presentations to policy makers –IGC through the ISDI Initiative – as soon as possible
Workshop for ISPLS annual conference
Workshop for annual GIS meeting

COSTS

The cost of putting on a workshop typically runs around $1,000 per workshop. In some cases a fee for attending may be charged to recover the costs. In other instances, volunteer efforts and donated services and/or facilities can reduce the costs.

Some of the considerations for workshop costs are:

- Speaker's fees and associated travel
- Course development
- Facilities and support rentals

Opportunities for sharing content with other groups doing similar training should be pursued.

GEODETIC AND MAPPING CONTROL I-PLAN

TASKS AND TIMELINES

This issue will be addressed either in a newly proposed I-Team and/or in each individual I-Team.

- Review draft policy – Geodetic Control Sub-TWG
- Edit and review draft policy – Geodetic Control Sub-TWG
- Review draft policy – Cadastral/Geodetic Control TWG
- Edit and review draft policy – Cadastral/Geodetic Control TWG
- Review draft policy - IGC
- Finalize policy – IGC
- Six months – one year